TITLE: HT21U22-100 Preliminary Product Specification

Rev. P1

Hyundai Display Technology Inc.

REVISION HISTORY

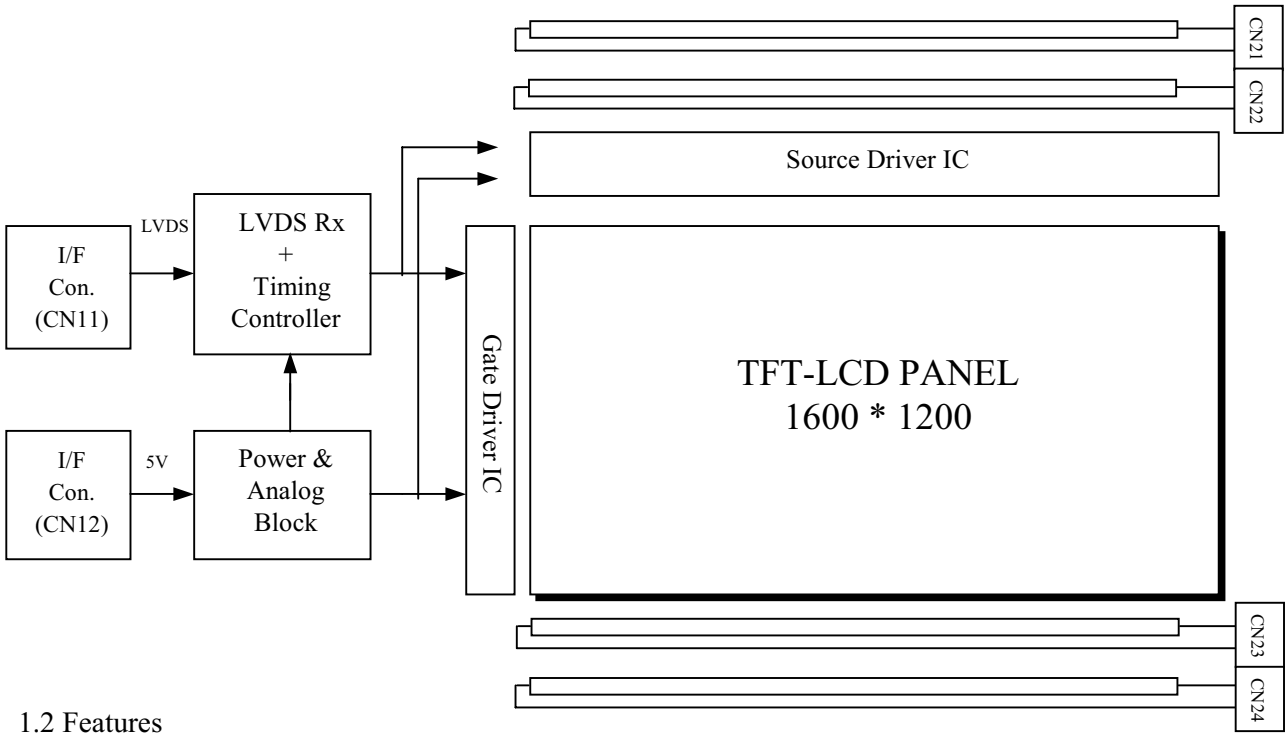
REV.	ECN NO.	DESCRIPTION OF CHANGES	DATE	PREPARED
P0		Initial Release	MAY. 02, '01	S.W.LEE
P1		1.Display colors (All pages) New: 262,144 / Old: 16,777,216 2.General specifications (Page 5) New: ±0.5 / Old: ±0.3 New: 3670 [gram] / Old: 4000 [gram] 3.Electrical specifications (Page 6) New: 648 [mA] / Old: 1300 [mA] New: 780 [mA] / Old: 860 [mA] New: 30,000 min.[hrs] / Old: 50,000 typ.[hrs] New: 3.24 [W] / Old: 6.5 [W] New: 18.9 [W] / Old: 22.4 [W] New: 22.14 [W] / Old: 28.9 [W] 4.Optical specifications (Page 7) New: CR>10 / Old: CR>5 New: 220 [cd/m^2] / Old: 200 [cd/m^2] New: 0.335 (yw) / Old: 0.326 (yw) New: 0.640 (x_R) / Old: 0.623 (x_R) New: 0.348 (y_R) / Old: 0.362 (y_R) New: 0.289 (x_G) / Old: 0.281 (x_G) New: 0.616 (y_G) / Old: 0.578 (y_G) New: 0.141 (x_B) / Old: 0.140 (x_B) New: 0.110 (y_B) / Old: 0.095 (y_B) New: 30 max (Response time, [ms]) / Old : 36 max (Response time, [ms]) 5.Back-light Interface Connections (Page 11) New: BHSR-02-VS-1 / Old: BHSR-03-VS-1 New: Pink/Blue / Old: Pink 6.Dimensional Parameters (Page 17) New: 3670 [gram] / Old: 4000 [gram]	JUL. 04, '01	S.W.LEE

Contents

1.0 GENERAL DESCRIPTION

1.1 Introduction

[HT21U22-100] is a color active matrix TFT LCD module using amorphous silicon TFT's (Thin Film Transistors) as an active switching devices. This module has a 21.3 inches diagonally measured active area with UXGA resolutions (1600 horizontal by 1200 vertical pixel array). Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical stripe and this module can display 262,144 colors. The TFT-LCD panel used for this module is a low reflection and higher color type.



1.2 Features

- LVDS Interface with 2 pixel / clock
- High-Speed Response (Using U-FFS Tech.)
- 262,144 Colors
- Incorporated Edge Type Back-Light (Four Lamps)
- High Luminance and Contrast Ratio, Low Reflection and Wide Viewing Angle
- DE (Data Enable) Mode Only

1.3 Applications

- Large-Size LCD Monitor for Professional CAD/CAM Design
- Slim-Size Display for Stand-alone Monitor
- Display Terminals for Control System
- Display Unit for Factory Automation

1.4 General Specifications

The followings are general specifications at the model [HT21U22-100].

<Table 1. General Specifications>

Parameter	Specification	Unit	Remarks
Active area	432.0(H) x 324.0(V)	mm	
Number of pixels	1600(H) x 1200(V)	pixels	
Pixel pitch	0.27(H) x 0.27(V)	mm	
Pixel arrangement	RGB Vertical stripe		
Display colors	262,144	colors	
Display mode	Normally Black		
Dimensional outline	483(H) x 373.2(V) x 24.5(D) [typ.]	mm	± 0.5
Weight	3670 [typ.]	gram	
Back-light	Top/Bottom edge side 4-CCFL type		Note 1

Note 1. CCFL (Cold Cathode Fluorescent Lamp)

2.0 ABSOLUTE MAXIMUM RATINGS

The followings are maximum values which, if exceed, may cause faulty operation or damage to the unit. The operational and non-operational maximum voltage and current values are listed in Table 2.

<Table 2. Absolute Maximum Ratings>

Parameter	Symbol	Min.	Max.	Unit	Remarks
Power Input Voltage	V_{DD}	-0.3	6.0	V	Ta = 25°C
Logic Input Voltage	V_{IN}	-0.3	4.3	V	
Back-light Lamp Voltage	V_{BL}	-0.3	14	V	
Back-light Lamp Current	I_{BL}	3	7	mA	
Operating Temperature (Humidity)	T_{OP} RH	0	+50 80	°C %	 ≤ 40 °C
Storage Temperature (Humidity)	T_{SP} RH	-20	+60 90	°C %	 ≤ 40 °C

3.0 ELECTRICAL SPECIFICATIONS

< Table 3. Electrical specifications > [Ta = 25± 2°C]

Parameter			Min.	Typ.	Max.	Unit	Remarks
Power Supply	Voltage	V_{DD}	4.5	5.0	5.5	V	
	Current	I_{DD}	-	648		mA	Note 1
High Level Differential Input Threshold Voltage		V_{IH}		-	100	mV	Note 2
Low Level Differential Input Threshold Voltage		V_{IL}	- 100	-	-	mV	
Back-Light Lamp	Voltage	V_{BL}	-	780	-	Vrms	
	Current	I_{BL}		6.5		MArms	Per CCFL
	Frequency	F_L	30	-	80	KHz	Note 3
	Start Voltage	V_S	-	-	1270	Vrms	25°C, Note 4
			-	-	1800	Vrms	0°C, Note 4
	Life Time	Hr	30,000	-	-	hrs	
Power Consumption		P_D	-	3.24	-	W	
		P_{BL}	-	18.9	-	W	Note 5
		P_{total}	-	22.14	-	W	

Notes:

1. Test Pattern of power supply current
   IDD (typ.): Vertical color bar pattern
2. The Input signals are LVDS signals. / LVDS Receiver Common Mode Voltage V_{CM} = 1.2[V].
3. The lamp frequency should be selected as different as possible from the horizontal synchronous frequency and its harmonics to avoid interference, which may cause line flow on the display.
4. The voltage above this value should be applied to the lamps for more than 1 second to startup. Otherwise the lamps may not to be turned on.
5. Calculated value for reference (V_{BL} x I_{BL}) x 4 excluding inverter loss.

4.0 OPTICAL SPECIFICATIONS

4.1 Overview

The test of Optical specifications shall be measured in a dark room (ambient luminance ≤ 1 lux and temperature = 25±2°C) with the equipment of Luminance meter system (Goniometer system and TOPCONE BM-5) and test unit shall be located at an approximate distance 50cm from the LCD surface at a viewing angle of θ and ϕ equal to 0°. We refer to $\theta_{\phi=0}$ (=θ_3) as the 3 o'clock direction (the "right"), $\theta_{\phi=90}$ (=θ_{12}) as the 12 o'clock direction ("upward"), $\theta_{\phi=180}$ (=θ_9) as the 9 o'clock direction ("left") and $\theta_{\phi=270}$(=θ_6) as the 6 o'clock direction ("bottom"). While scanning θ and/or ϕ, the center of the measuring spot on the display surface shall stay fixed. The measurement shall be executed after 30 minutes warm-up period. VDD shall be 5.0V +/- 10% at 25°C. Optimum viewing angle direction is 6 o'clock.

4.2 Optical Specifications

<Table 4. Optical Specifications>

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Viewing Angle Range	Horizontal	θ_3	CR > 10	80		-	Deg.	Note 1
		θ_9		80		-	Deg.	
	Vertical	θ_{12}		80		-	Deg.	
		θ_6		80		-	Deg.	
Luminance Contrast Ratio		CR	θ = 0°		300	-		Note 2
Luminance of White		Y_w	θ = 0°		220	-	cd/m^2	Note 3
White luminance Uniformity		Δ Y	IBL = (6.5mA)	-		1.4		Note 4
Reproduction Of Color	White	x_w	θ = 0°		0.312			Note 5
		yw			0.335			
	Red	x_R			0.640			
		y_R			0.348			
	Green	x_G			0.289			
		y_G			0.616			
	Blue	x_B			0.141			
		y_B			0.110			
Response Time (Decay + Rise)		Ttotal	Ta= 25°C θ = 0°	-	-	30	ms	Note 6
Cross Talk		CT	θ = 0°	-	-	4.0	%	Note 7

Notes:

1. Viewing angle is the angle at which the contrast ratio is greater than 5. The viewing are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface (See FIGURE 1 shown in Appendix).
2. Contrast measurements shall be made at viewing angle of $\theta = 0°$ and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black) state. (See FIGURE 1 shown in Appendix) Luminance Contrast Ratio (CR) is defined mathematically.

$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

3. Center Luminance of white is defined as the LCD surface. Luminance shall be measured with all pixels in the view field set first to white. This measurement shall be taken at the locations shown in FIGURE 2 for a total of the measurements per display.
4. The White luminance uniformity on LCD surface is then expressed as : ΔY = Maximum Luminance of five points / Minimum Luminance of five points (See FIGURE 2 shown in Appendix).
5. The color chromaticity coordinates specified in Table 4. shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.
6. The electro-optical response time measurements shall be made as FIGURE 3 shown in Appendix by switching the "data" input signal ON and OFF. The times needed for the luminance to change from 10% to 90% is Tr, and 90% to 10% is Td.
7. Cross-Talk of one area of the LCD surface by another shall be measured by comparing the luminance (Y_A) of a 25mm diameter area, with all display pixels set to a gray level, to the luminance (Y_B) of that same area when any adjacent area is driven dark. (See FIGURE 4 shown in Appendix).

5.0 INTERFACE CONNECTION

5.1 Electrical Interface Connection

- CN11: Module-Side Connector (LVDS Signal) : FI-X30S-HF (JAE) or Equivalent
  User-Side Connector : FI-X30H-HF (JAE) or Equivalent
- CN12: Module Side Connector (Power) : 53261-1290 (Molex) or Equivalent
  User-Side Connector : 51021-1200 (Molex) or Equivalent

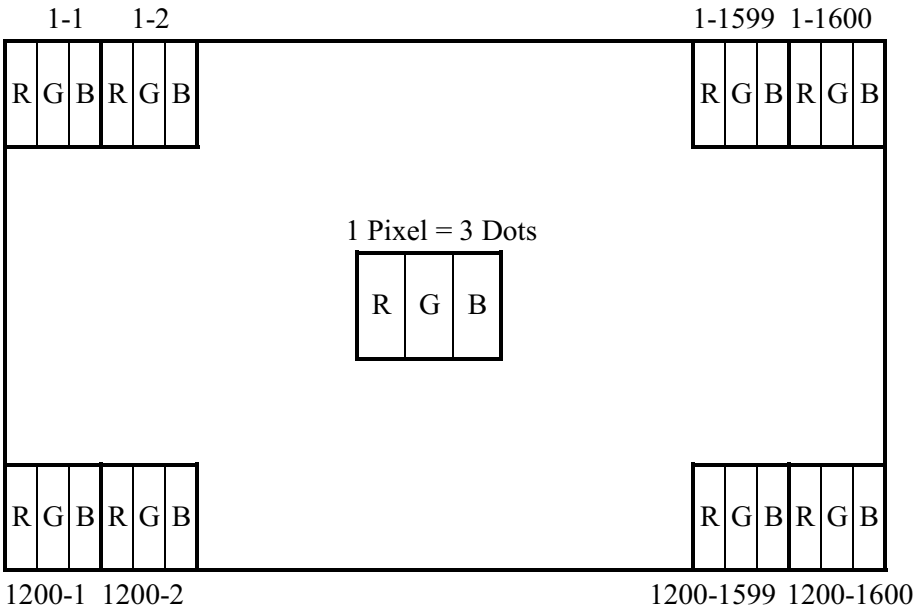
<Table 5. Pin Assignment for Receiver Interface Connection>

CN11			CN12		
Pin No	Symbol	Function	Pin No	Symbol	Function
1	RXO0-	LVDS Signal Odd Pixel 0-	1	VIN0	Power +5[V]
2	RXO0+	LVDS Signal Odd Pixel 0+	2	VIN1	Power +5[V]
3	RXO1-	LVDS Signal Odd Pixel 1-	3	VIN2	Power +5[V]
4	RXO1+	LVDS Signal Odd Pixel 1+	4	VIN3	Power +5[V]
5	RXO2-	LVDS Signal Odd Pixel 2-	5	VIN4	Power +5[V]
6	RXO2+	LVDS Signal Odd Pixel 2+	6	VIN5	Power +5[V]
7	GND	Ground	7	GND	Ground
8	RXOC-	LVDS Signal Odd CLK-	8	GND	Ground
9	RXOC+	LVDS Signal Odd CLK+	9	GND	Ground
10	RXO3-	LVDS Signal Odd Pixel 3-	10	GND	Ground
11	RXO3+	LVDS Signal Odd Pixel 3+	11	GND	Ground
12	RXE0-	LVDS Signal Even Pixel 0-	12	GND	Ground
13	RXE0+	LVDS Signal Even Pixel 0+			
14	GND	Ground			
15	RXE1-	LVDS Signal Even Pixel 1-			
16	RXE1+	LVDS Signal Even Pixel 1+			
17	GND	Ground			
18	RXE2-	LVDS Signal Even Pixel 2-			
19	RXE2+	LVDS Signal Even Pixel 2+			
20	RXEC-	LVDS Signal Even CLK-			
21	RXEC+	LVDS Signal Even CLK+			
22	RXE3-	LVDS Signal Even Pixel 3-			
23	RXE3	LVDS Signal Even Pixel 3+			
24	GND	Ground			
25	NC1	-			
26	DE	Data Enable			
27	NC2	-			
28	VDD1	Power +5[V]			
29	VDD2	Power +5[V]			
30	VDD3	Power +5[V]			

5.2 LVDS Interface (Recommended TX : THC63LVDM83A)

	Input signal	Transmitter Pin No	Transmitter Pin No	Interface System (Tx)	Interface TFT-LCD (Rx)	FI-X30S-HF Pin No.	Remark
ODD LVDS	OR0	51	48 47	OUT0- OUT0+	RXO0- RXO0+	1 2	
	OR1	52					
	OR2	54					
	OR3	55					
	OR4	56					
	OR5	3					
	OG0	4					
	OG1	6	46 45	OUT1- OUT1+	RXO1- RXO1+	3 4	
	OG2	7					
	OG3	11					
	OG4	12					
	OG5	14					
	OB0	15					
	OB1	19					
	OB2	20	42 41	OUT2- OUT2+	RXO2- RXO 2+	5 6	
	OB3	22					
	OB4	23					
	OB5	24					
	HSYNC	27					
	VSYNC	28					
	DE	30					
	MCLK	31	40 39	CLKOUT- CLKOUT+	RXO CLK- RXO CLK+	8 9	
	OR6	50	38 37	OUT3+ OUT3-	RXO 3- RXO 3+	10 11	
	OR7	2					
	OG6	8					
	OG7	10					
	OB6	16					
	OB7	18					
	RSVD	25					
EVEN LVDS	ER0	51	48 47	OUT0- OUT0+	RXE0- RXE 0+	12 13	
	ER1	52					
	ER2	54					
	ER3	55					
	ER4	56					
	ER5	3					
	EG0	4					
	EG1	6	46 45	OUT1- OUT1+	RXE 1- RXE 1+	15 16	
	EG2	7					
	EG3	11					
	EG4	12					
	EG5	14					
	EB0	15					
	EB1	19					
	EB2	20	42 41	OUT2- OUT2+	RXE 2- RXE 2+	18 19	
	EB3	22					
	EB4	23					
	EB5	24					
	HSYNC	27					
	VSYNC	28					
	DE	30					
	MCLK	31	40 39	CLKOUT- CLKOUT+	RXE CLK- RXE CLK+	20 21	
	ER6	50	38 37	OUT3+ OUT3-	RXE 3- RXE 3+	22 23	
	ER7	2					
	EG6	8					
	EG7	10					
	EB6	16					
	EB7	18					
	RSVD	25					

5.3 Data Input Format



Display Position of Input Data (V–H)

5.4 Back-light Interface Connections

● Lamp Input : [CN21,22,23,24]
Module Side Connector : BHSR-02-VS-1 (JST)
User Side Connector : SM02(8.0)B-BHSS-1-TB (JST) or equivalent

<Table 6. Back-light Electrical Interface>

Terminal No.	INPUT	Color	Function
1	HOT	Pink/Blue	High Voltage
2	COLD	White	Ground

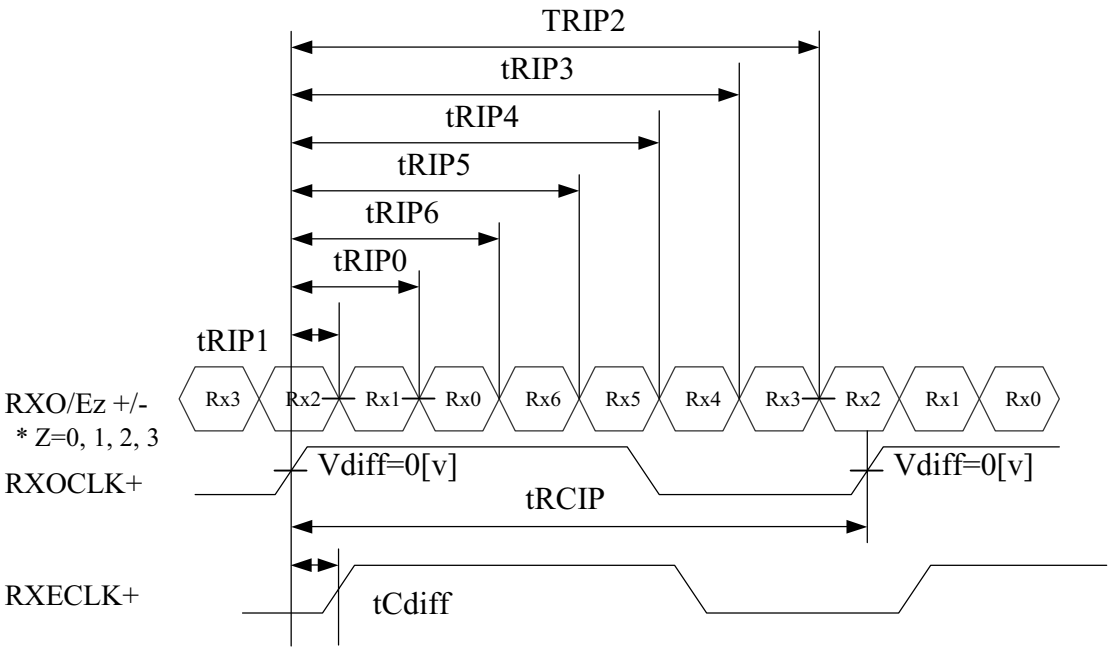
6.0 SIGNAL TIMING SPECIFICATIONS

6.1 LVDS Rx interface timing parameter

The specification of the LVDS Rx interface timing parameter is listed in Table 7.

< Table 7. LVDS Rx Interface Timing Specification>

Item	Symbol	Min	Typ	Max	Unit	Remark
CLKIN Period	tRCIP	14.7	18.5	-	ns	
CLK Difference	tCdiff	TBD	0	TBD	ns	
Input Data 0	tRIP1	-0.2	0	+0.2	ns	
Input Data 1	tRIP0	1*tRICP/7-0.2	1*tRICP/7	1*tRICP/7+0.2	ns	
Input Data 2	tRIP6	2*tRICP/7-0.2	2*tRICP/7	2*tRICP/7+0.2	ns	
Input Data 3	tRIP5	3*tRICP/7-0.2	3*tRICP/7	3*tRICP/7+0.2	ns	
Input Data 4	tRIP4	4*tRICP/7-0.2	4*tRICP/7	4*tRICP/7+0.2	ns	
Input Data 5	tRIP3	5*tRICP/7-0.2	5*tRICP/7	5*tRICP/7+0.2	ns	
Input Data 6	tRIP2	6*tRICP/7-0.2	6*tRICP/7	6*tRICP/7+0.2	ns	



* Vdiff = (RXO/Ez+)-(RXO/Ez-), ….. , (RXO/ECLK+)-(RXO/ECLK-)

6.2 Signal Timing Specifications

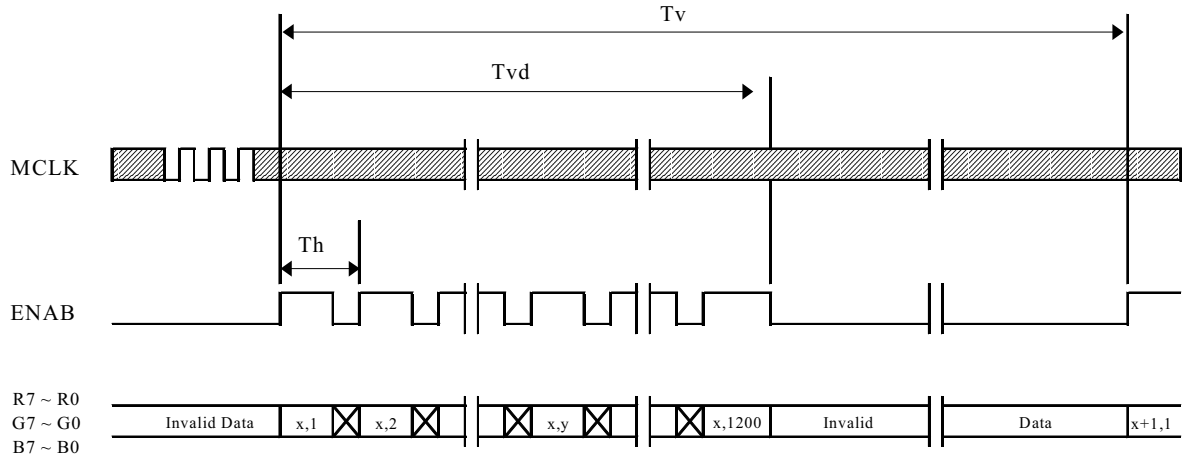
The specification of the signal timing parameter is listed in Table 8. The [HT21U22-100] is operated by the Only Data Enable Mode.

<Table 8. Signal Timing Specifications>

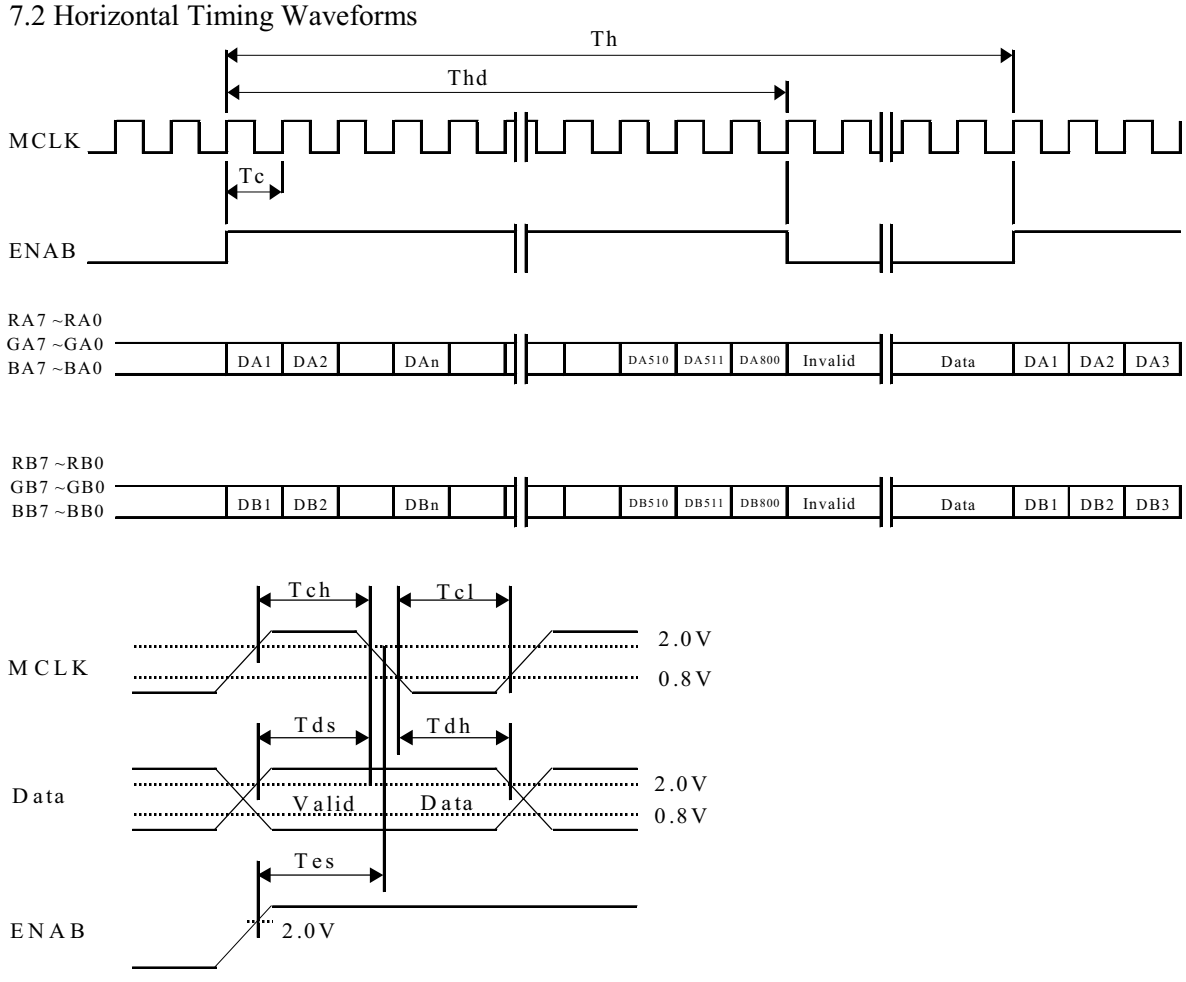
Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	25	40.5	42.5	MHz
	High Time	Tch		12.3	-	ns
	Low Time	Tcl		12.3	-	ns
Data	Setup Time	Tds	4	-	-	ns
	Hold Time	Tdh	4	-	-	ns
Data Enable Setup Time		Tes	4	-	-	ns
Frame Period		Tv	1206	1250	2044	lines
Vertical Display Period		Tvd	1200	1200	1200	lines
One Line Scanning Period		Th	848	1080	2022	clocks
Horizontal Display Period		Thd	800	800	800	clocks

7.0 SIGNAL TIMING WAVEFORMS

7.1 Vertical Timing Waveforms



7.2 Horizontal Timing Waveforms



8.0 INPUT SIGNALS, BASIC DISPLAY COLORS & GRAY SCALE OF COLORS

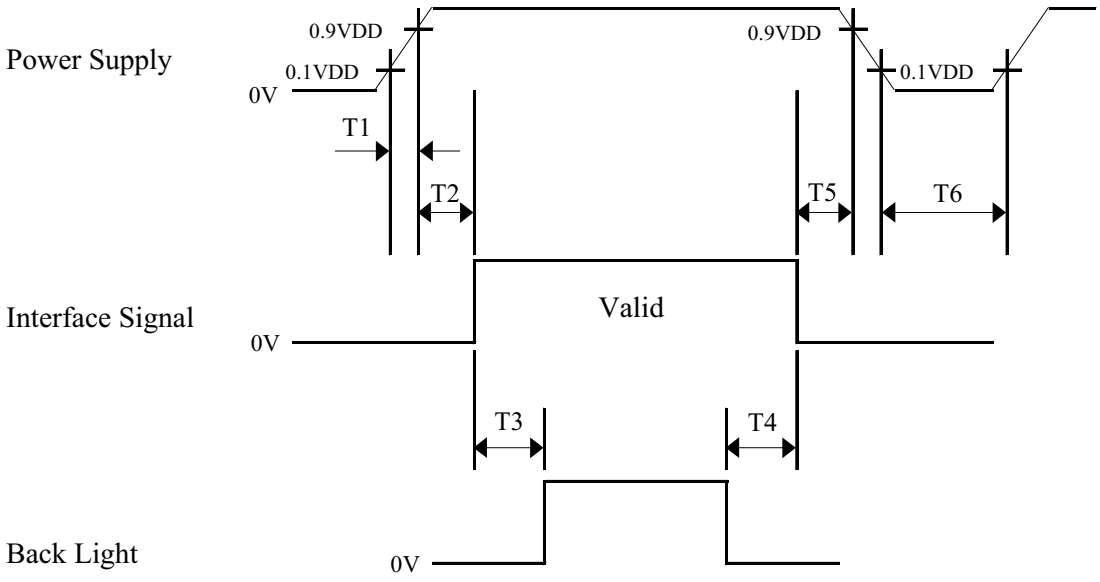
Each color is displayed in 16,777,216 gray scales from 8 bits data signal input. Table 9 shows the 8 bits input signals for basic display colors and gray scale.

<Table 9. 8 Bits Input signals, basic display colors and gray scale for each color>

Colors & Gray Scale		Data Signal																							
		Red								Green								Blue							
	Odd & Even	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gray Scale Of Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	↓								↓								↓							
	↓	↓								↓								↓							
	Brighter	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↓	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Scale Of Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑	↓								↓								↓							
	↓	↓								↓								↓							
	Brighter	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	↓	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Gray Scale Of Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑	↓								↓								↓							
	↓	↓								↓								↓							
	Brighter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	↓	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Gray Scale Of White & Black	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	Darker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
	↑	↓								↓								↓							
	↓	↓								↓								↓							
	Brighter	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1
	↓	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

9.0 POWER SEQUENCE

To prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown in below



- T1 ≤ 10 ms
- T2 ,T5 ≤ 50 ms
- 100 ms ≤ T3, T4 ≤ 200 ms
- T6 ≤ 1 sec

Notes:

1. When the power supply VDD is 0[V], Keep the level of input signals on the low or keep the high impedance.
2. Do not keep the interface signal high impedance when power is on.
3. Back-light must be turn on after power for logic and interface signals are valid.

10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

FIGURE 6 is shown in appendix shows mechanical outlines for the model [HT21U22-100]. Other parameters are shown in Table 10.

<Table 10. Dimensional Parameters>

Parameter	Specification	Unit
Active area	432.0(H) x 324.0(V)	mm
Number of pixels	1600(H) x 1200(V)	pixels
	(1 pixel = R + G + B dot)	
Pixel pitch	0.27(H) x 0.27(V)	mm
Pixel arrangement	RGB Vertical stripe	
Display colors	262,144	colors
Display mode	Normally Black	
Dimensional outline	483± 0.5(H) x 373.2± 0.5(V) x 24.5± 0.5(D)	mm
Weight	3670 [typ.]	gram
Back-light	Top/Bottom edge side 4-CCFL type	

10.2 Mounting

See FIGURE 5 shown in appendix

10.3 Anti-Glare and Polarizer Hardness.

The surface of the LCD has an anti-glare coating to minimize reflection and a coating to reduce scratching.

10.4 Light Leakage

There shall not be visible light from the back-lighting system around the edges of the screen as seen from a distance 50[cm] from the screen with an overhead light level of 350[lux].

The manufacture shall furnish limit samples of the panel showing the lightest leakage acceptable.

11.0 RELIABILITY TEST

The Reliability test items and its conditions are shown in below.

<Table 11. Reliability Test Parameters>

No	Test Items	Conditions
1	High temperature storage test	Ta = 60 °C, 240 hrs
2	Low temperature storage test	Ta = -20 °C, 240 hrs
3	High temperature & high humidity operation test	Ta = 40 °C, 75 %RH, 240 hrs
4	High temperature operation test	Ta = 50 °C, 240 hrs
5	Low temperature operation test	Ta = 0 °C, 240 hrs
6	Thermal shock	Ta = 0 °C ↔ 50 °C (30 min), 100 cycle
7	Vibration test (non-operating)	Frequency : 10 ~ 300 Hz Gravity/AMP : 1.0G Period : X, Y, Z 30 min
8	Shock test (non-operating)	Gravity : 100G Pulse width : 6ms, half sine wave Direction ± X, ± Y, ± Z Once for each direction
9	Electrostatic discharge test	Air : 150 pF, 330Ω , 15KV, 5times Contact : 150 pF, 330Ω , 8KV, 5times

12.0 HANDLING & CAUTIONS

12.1 Cautions when taking out the module

- Pick the pouch only, when taking out module from a shipping package.

12.2 Cautions for handling the module

- As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
- As the LCD panel and back-light element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
- As the surface of the polarizer is very soft and easily scratched, use a soft dry-cloth without chemicals for cleaning.
- Do not pull the interface connector in or out while the LCD module is operating.
- Put the module display side down on a flat horizontal plane.
- Handle connectors and cables with care.

12.3 Cautions for the operation

- When the module is operating, do not lose LVDS signals. If any one of these signals were lost, the LCD panel would be damaged.
- Obey the supply voltage sequence. If the wrong sequences were applied, the module would be damaged.

12.4 Cautions for the atmosphere

- Dew drop atmosphere should be avoided.
- Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer-packing pouch and under relatively low temperature atmosphere is recommended.

12.5 Cautions for the module characteristics

- Do not apply fixed pattern data signal to the LCD module at aging time.
- Applying fixed pattern for a long time may cause image sticking.

12.6 Other cautions

- Do not disassemble and/or re-assemble LCD module.
- Do not re-adjust variable resistor or switch etc.
- When returning the module for repair or etc, please pack the module not to be broken. We recommend on using the original shipping packages.

13.0 APPENDIX

Figure 1. Measurement Set Up

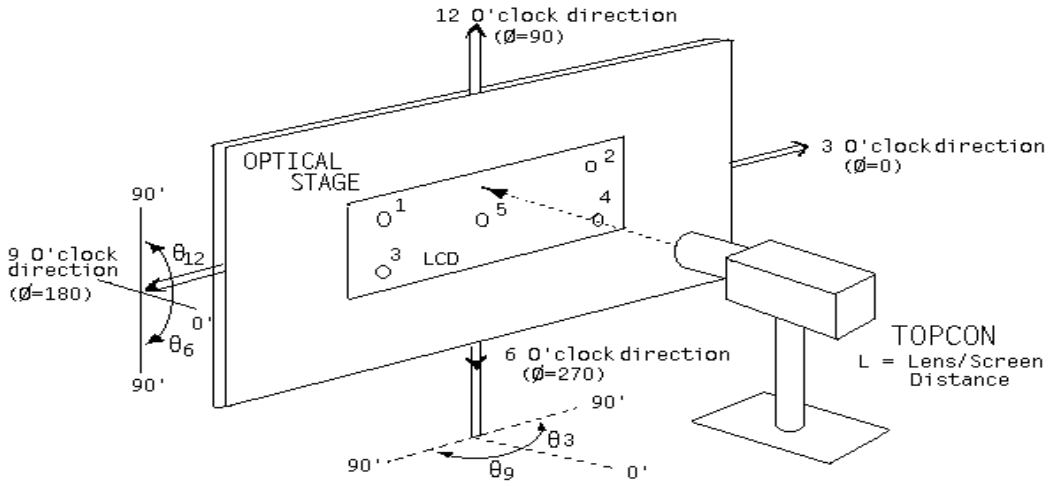


Figure 2. Average Luminance Measurement Locations & Uniformity Measurement Locations

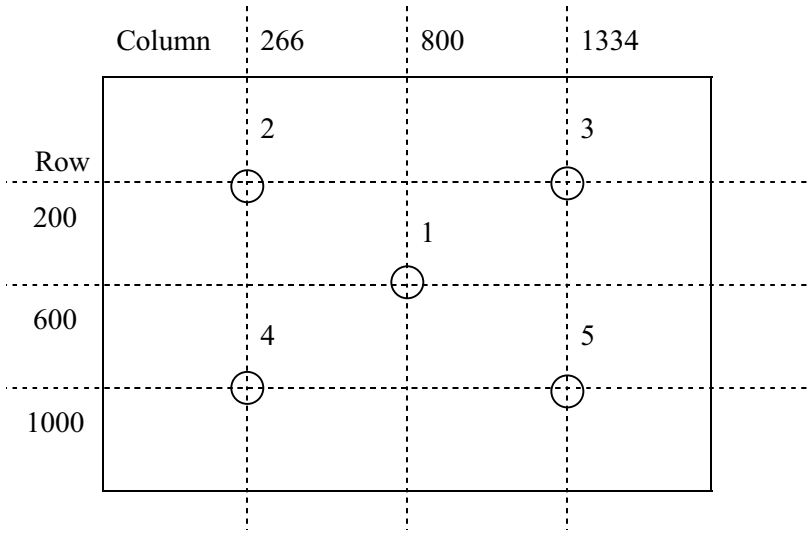


Figure 3. Response Time Testing

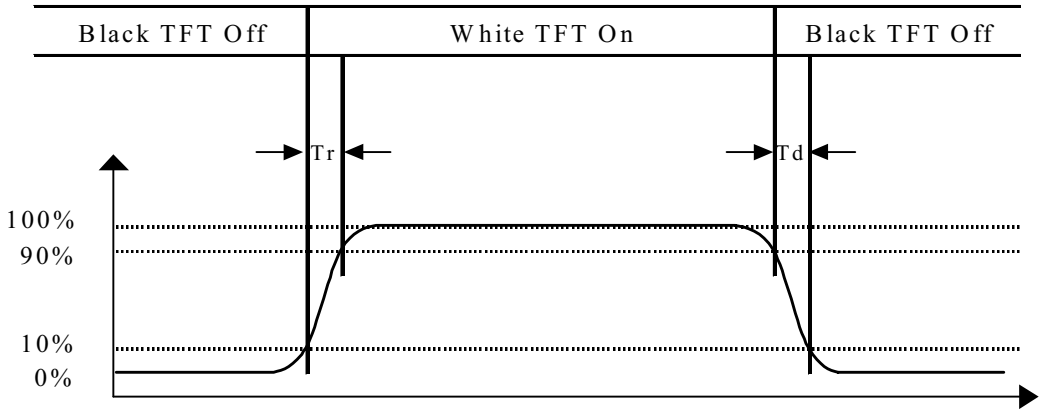
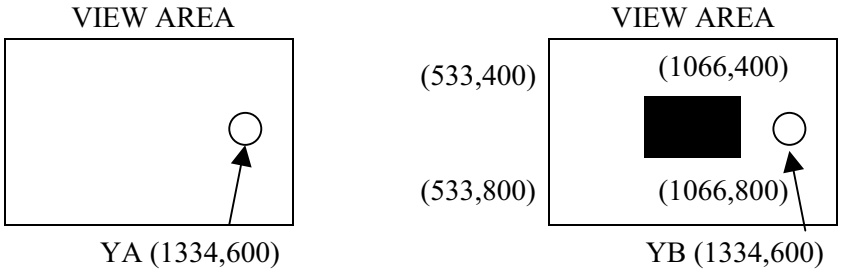


Figure 4. Cross Modulation Test Description



$$\text{Cross-Talk} = \left| \frac{YB - YA}{YA} \right| \times 100$$

Where:
Y_A = Initial luminance of measured area (cd/m^2)
Y_B = Subsequent luminance of measured area (cd/m^2)
The location measured will be exactly the same in both patterns.

Figure 5. TFT-LCD Module Outline Dimensions (Front view)

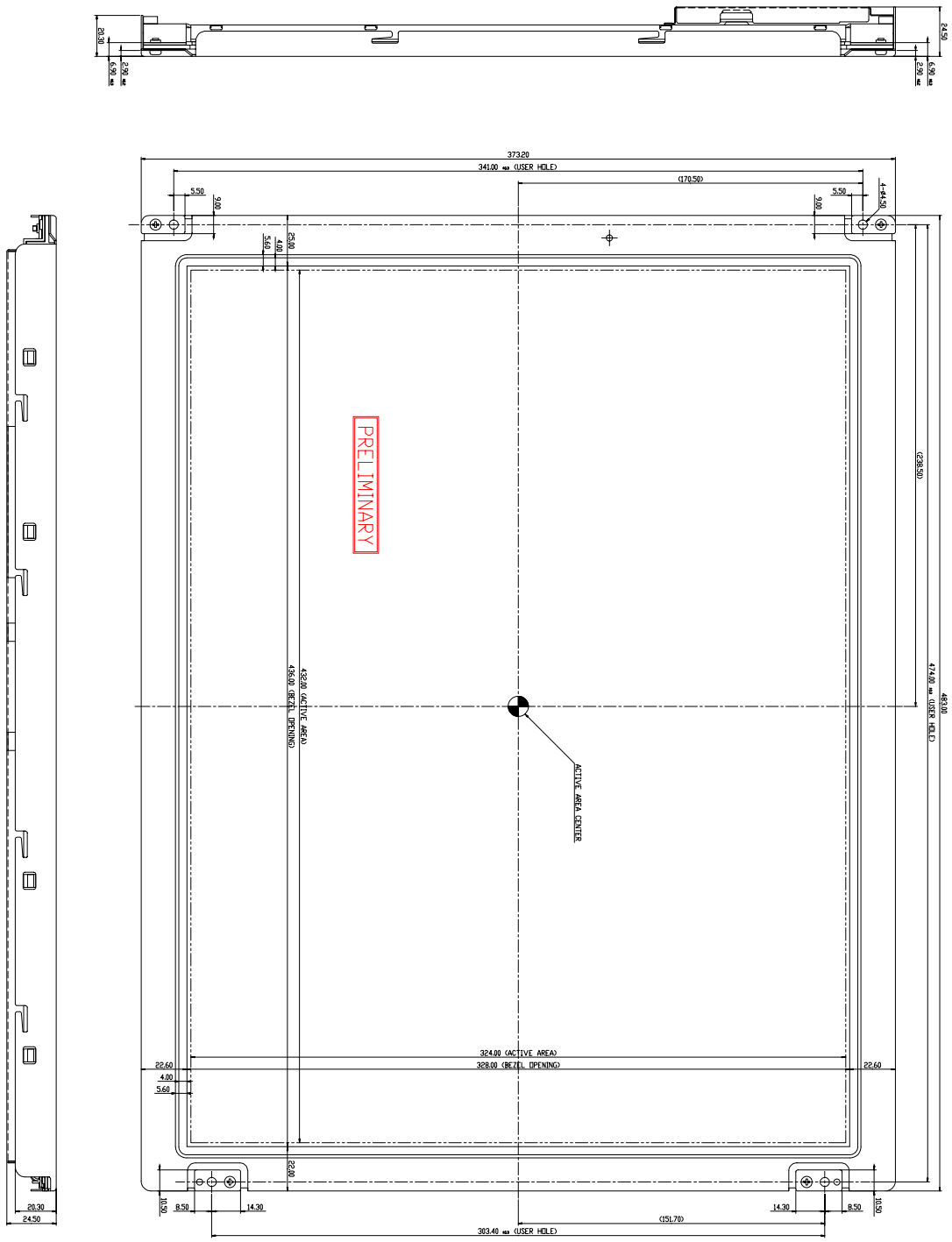


Figure 6. TFT-LCD Module Outline Dimensions (Rear view)